BILAGA TILL SVENSK PATENTTIDNING NR 2001/04 2001-01-29

9902972-0 A01J 7/00

SVERIGE (L) ALLMÄNT TILLGÄNGLIG
(22) ANS DAT 1999-08-23 (21) ANS NR 9902972-0
(24) LÖPDAT 1999-08-23 ANSVK J2JH
(51) KLASS G01N 33/04
A01J 7/00
(41) OFF DAT 2000-12-15 (74) OMBUD Albihns Stockholm AB

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(30) PRIORITETSUPPGIFTER
(54) BENÄMNING En metod och ett system för analysering av mjölk under mjölkningsprocessen
(57) SAMMANDRAG

Ett system och ett förfarande för att fastställa ett hälsotillstånd för ett djur, såsom en ko eller ett får, genom att analysera mjölk från djuret under eller efter mjölkningsproceduren.

Enligt uppfinningen insamlas ett mjölkprov från den sista delen av mjölkningsproceduren av insamlingsmedel (4) och analyseringsmedel (6A,6B,6C,8') används för att göra analyser av det insamlade mjölkprovet.

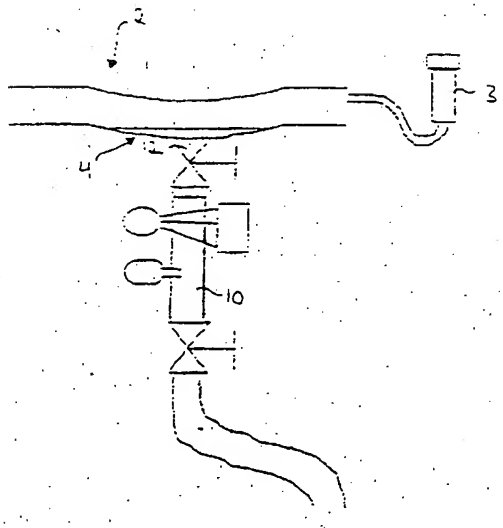

Fig. 4

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Patent- och Registreringsverket

Stockholm

NY ANSÖKAN OM SVENSKT PATENT

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Vår ref: 55250

UPPFINNINGENS BENÄMNING	A method and a system for analysing milk during the milking operation
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BEGÄRAN OM PRIORITET (datum, land och ansökningsnr.)	
VID DEPOSITION AV MIKROORGANISM	*Depositionsmyndighet* — *Depositionsnummer*
VID AVDELAD ELLER UTBRUTEN ANSÖKNING	*Stamansökningsnummer* — *Begärd löpdag*

BILAGOR

x Engelsk beskrivning, patentkrav och sammandrag i 2 ex (avser Fig. 2)
x 3 ritningar i 2 exemplar
x Överlåtelsehandling
Fullmakt
Utländsk text,
Prioritetsbevis
Ev. sekvenslista i maskinläsbar form

Stockholm den 23 augusti 1999

ALBIHNS PATENTBYRÅ STOCKHOLM AB

Åsa Ahlgren

AVGIFT

x Grundavgift 3 800:-
x Tilläggsavgift 1.900:- för patentkrav över 10
x Grundavgift 5 510:- för ITS-granskning

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A method and a system for analysing milk during the milking operation

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method and a system for establishing a health condition of an animal, such as a cow or a sheep by analysing milk from the animal, during or after a milking operation.

RELATED ART

A system and method of a related kind is disclosed in US 4.385.590 and also in US 5.704.311. The first document describes a mastitis detection system wherein the milk from each cow is caused to pass a filtering cell. A light source is provided on one side of the filter and a light detector on the other side. Thus white clotted material from the milk infected by mastitis will be collected on the filter and optically detected. The second document describes an apparatus for automatically analysing of the milk from each udder quarter.

SUMMARY

One problem with these analysing methods is that they do not pay regard to the fact that the milk coming out from the udder at the beginning of the milking was produced many hours ago. The analysed milk is thus not representative for the health of the udder at the time of the actual milking.

It is important to detect an inflammation in the udder quarter as early as possible since it can then be cured much easier. It is also important that the analysing is done separately on the milk from each udder quarter. The milk is produced separately and the udder quarters can be sick independently of each other. It is of course good to know in which udder quarter the disease has occurred but it is also

the inflammation if the milk from one udder quarter, which can be unhealthy, is not mixed with healthy milk from the other udder quarters in the same udder.

An object of the present invention is to provide a milk analysing apparatus and method that performs the analysing on milk that is representative for the health of each udder quarter at the time of the analyse.

The analyse can give information about, for example the relative amount of cells in the milk, which indicates infections and inflammations, the relative amount of salt ions, which also indicates inflammations and the relative amount of progesterone, which tells if the cow is in heat. The results from the analyses may be registered and stored in databases. Each cow will have its own health-over-time diagram.

The above mentioned object has been achieved by an analysing system of the initially defined kind, which is characterised by capturing means for capturing a milk sample from the last part of the milking operation, and analysing means for analysing the captured milk sample.

The object has also been achieved by a method of the initially defined kind, which is characterised by capturing a sample of the milk from the last part of the milking operation and analysing the captured sample. This analysing of the milk from the last part of the milking operation gives analysis results which are representative of the udder health at the time for the analysis.

The analysing is preferably done on milk from each udder quarter separately. This will give information about the health of each udder quarter.

Suitably the light transmission, reflection or absorption of the milk sample is measured. Thus each capturing means has a wall provided with a light source means outside one wall side and a light detector means outside the opposite wall side, said

wall sides being transparent for the wavelengths of the actual light to be detected. This measurement gives information about clods, effected by for example mastitis, in the milk.

Suitably specific wavelengths absorbed by specific compounds are selected by a wavelength selector and used for the measuring of the light transmission, reflection or absorption of the milk sample. Thus the amount of specific compounds in the milk can be determined with the light detection method.

The conductivity of the milk from the last part of the milking operation could also preferably be measured. The conductivity increases when the amount of salt ions increases and the amount of salt ions in the milk may indicate the quality of the milk and inflammatory states of the udder quarter.

A milk sample could preferably be captured in a catch pocket, for example a bent, a larger diameter line section, a threshold or an extension in a milk transport line. This catch pocket will automatically store the milk from the last part of the milking operation.

An analysing operation could suitably be provided when the milk to be analysed is left in the catch pocket of the milk transport line. Then a separate sample container is not needed and no devices for taking the sample out from the line either.

An airflow produced by an airflow device could also be provided in the milk transport line for stirring the milk sample during the analysing operation. The stirring is needed to see any differences in the transmission caused by clods.

A milk sample could also be captured in a separate sample container when the milking operation is about to end. One advantage with taking a sample out from the line is that the analysis of the milk can be a destroying analysis

A normally closed valve is suitably provided between a milk transport line and the sample container; and the valve is preferably opened by control means when milk is to be captured.

Preferably a flow sensor in each milk transport line is sensing the milk flow; and sending a signal for the valve to open,

a) when the sensed milk flow has sunken below a predetermined rate or

b) when the sensed milk flow has sunken below a predetermined rate below the rate during the first and/or the middle part of the milking.

The milk sample is then ensured to be a sample of the milk from the last part of the milking operation.

The valve could also be opened by the control means after a predetermined time period.

Another possibility is to connect the valve of the sample container to the catch pocket in the line, where the milk sample automatically stays. Thus the advantage with a separate sample container is utilised and also the advantage of automatically capturing of the sample in the catch pocket. The point of time for opening the valve is then not critical. The flow rate need not to be measured, since the opening of the valve can be delayed until it is clear that the milking operation is finished.

A biosensor can be provided in the sample container in purpose of measuring the relative amount of different constituents in the milk such as progesterone, urea and keton bodies. The amount of progesterone tells if the cow is in heat. This is important to know for the insemination. The amount of urea may be used to assess the amount of protein or the balance protein/energy fed to the cow and keton bodies occurs in the milk when the cow is not given enough energy and has to brake down the muscles to get energy

Suitably the sample container is drained and washed through a second valve in the sample container.

Preferably the analysing results are stored in databases for each cow. The results may then be used for statistics of the health of the cows.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A, 1B, 1C, 1D and 2 illustrates schematically a first embodiment of the invention.

Fig. 3 illustrates schematically a second embodiment of the invention.

Fig. 4 illustrates schematically a third embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 1A shows a first embodiment of the invention. The milk from each udder quarter of a cow is transported through a separate milk transport line 2 to a milk container 3. Only one of the four systems is shown. The milk transport line 2 is provided with a capturing means in the form of a catch pocket, for example a bent 4 in the milk transport line 2 wherein the milk from the last part of the milking stays, when the milking is over. The line 2 is dimensioned for letting the milk flow through as regularly as possible. This could be a line diameter of about 10-20 mm. The depth of the bent 4 is a few mm, which will give a rather thin layer of milk to analyse. A thin layer is preferred in the analysing because then separate clods can be detected. Analysing means, preferably in the form of a light source, such as a light emitting diode, LED, 6 on one side of the line and a light sensitive detector 8 on the other side, is provided. The line then has to be transparent for getting the light

through, at least for light wavelengths used for the analysis. Possible materials are for example glass or plastic materials. As illustrated, the light detector 8 is extended in the direction of the line 2. The detector 8 could comprise only one detector element but could also comprise an array of separate detector elements which will detect light from the light source 6 in different directions. The detector 8 should be shielded from disturbing light.

In figures 1B, 1C and 1D there are shown three types of catch pockets as alternatives to the bent 4. The milk from the last part of the milking operation will automatically stay in each one of these alternatives. In fig. 1B one section of the line 2 is exchanged to a larger diameter line section 30. In fig. 1C a threshold 32 is placed in the bottom of the line 2 and in fig. 1D an extension 34 is made in the bottom of the line 2.

Fig. 2 illustrates that the light source 6 and the detector 8 in fig. 1A can change places so that for example an extended detector 8' is positioned in a closed relationship with the milk to be analysed. Also illustrated in Fig. 2 is that there could be a number of light sources 6A,6B,6C which can be controlled to be lightened at different times and also have mutually different light wavelengths.

The white clotted material in the milk caused by mastitis will thus be optically detected. To easier detect a variation in the light transmission the milk may be stirred a little in the bent. This movement is effected by for example an airflow in the line 2 provided by an airflow device 21 connected to the line 2. The airflow is pulsating in order to make the milk stirring. If then differences are detected in the light transmission the presence of clods is ensured. The airflow device 21 is particularly important when the detector 8' comprises only one detector element. Then the signal is captured during a certain time and the fluctuation of the signal is analysed.

The light source(s) 6A,6B,6C and the detector elements in the detector array 8' are thus connected to a control and processing device 9 which lightens the light source(s) 6A,6B,6C and derives the signals from the detector elements and processes these signals in order to provide an analyse result which can be presented for the operator and/or be stored for further analyse of the cow and her health.

Fig. 3 shows a second embodiment of the invention wherein a milk transport line 11 is connected to a capturing means in the form of a sample container 10, through a normally closed valve 12. A milk metering device 14 present in each line 11 comprises a flow sensor 13. To make sure that the sample is taken from the last milk of the milking operation a signal from the flow sensor 13 is fed to a processing device 15 which monitors the sensor signal and feeds a signal for the valve 12 of the container 10 to open up and let the milk in when the milk flow sensed by the flow sensor 13 has sunken below a predetermined rate, or below a predetermined rate in relation to the full rate during the actual milking. An alternative to this is to rely on old, stored data for each cow in a database 17, connected or connectable to the processing device 15 and open up the valve 12 after a time period when the milking for this particular cow is going to end according to the stored data.

The analysing is performed in the same way as in the first embodiment. A light emitting diode, LED, 6'' is provided on one side of the container 10 and on the other side a light sensitive detector 8'' connected to the device 15 is provided. The sample container 10 is thus transparent for the light used for the analysis. In this embodiment an analysing means 16 for measuring the conductivity of the milk is also provided and its signal is fed to the processing device 15. In the presence of an inflammation in the udder the amount of salt ions is increased, and the conductivity increases. In the bottom of the container 10 a second valve 18 is provided. This valve 18 is normally closed but opened for draining by control of the processing device 15. This second valve 18 is connected to a line 20 for washing.

The device 16 for measuring the conductivity can also be implemented in the first embodiment. If it is enough with only the conductivity measurements the capturing means 4 and 10 do not have to be transparent.

In the second embodiment, where a sample is taken out from the milk flow and can be thrown away after the analysis, there are other possible analysing methods. For example a biosensor 22 can be placed in the container 10. Biosensors are nowadays used for detection of for example urea, progesterone and keton bodies. The relative amount of urea may be used to assess the amount of protein or the balance protein/energy fed to the cow. The relative amount of progesterone indicates if the cow is in heat. The relative amount of progesterone in the milk decreases when the cow is in heat and thus analysing of milk is a god way to make sure when the heat occurs. Keton bodies occurs in the milk when the cow is not given enough energy and has to brake down the muscles to get energy. It is then to be noted that all the analysing devices shown in Fig. 3 do not necessarily have to be provided simultaneously.

Another analysing method, which can be used in the second embodiment, is the addition of a special reagent. The reagent will indicate the amount of cells by producing eye detectable clods and also a colour shift detectable by a wavelength specific LED and detector combination.

The light detection methods are however the most preferred detection methods. They can be used in both the first and the second embodiment and these methods do not effect the milk. NIR, near infrared radiation, or MIR, mid infrared radiation, is suitable for detection of clods in milk. Also specific wavelengths absorbed by specific molecules in compounds in the milk, such as fat, somatic cells, blood or enzymes may be used. This is illustrated with a wavelength selector 7 in figure 3, which chooses a suitable wavelength for the present need. Of course this wavelength selector could be used in all the described embodiments of the invention.

Other possibilities for getting a specific wavelength are to use a wavelength specific LED or a wavelength specific detector.

Another possibility with the light detection is to use at least two detectors side by side. When the signal is different on the two detectors the presence of clods is ensured.

Fig. 4 shows a third embodiment of the invention, which is a combination of the first and second embodiments. The catch pocket 4, 30, 32, 34 from the first embodiment is kept but in the bottom of the catch pocket 4, 30, 32, 34 the sample can be taken out for analyses in a separate sample container 10 as in the second embodiment. An advantage with this is that the analysis can proceed for a longer time than in the first embodiment, where the analysis has to be completed before the next cow is being milked. Another advantage is that the sample can be thrown away after the analysis. This means that the analysis can be a destroying analysis, like the reagent method. The flow rate does not need to be measured since the opening of the valve 12 in this embodiment can be performed when the milking of the cow has finished. The processing is performed in much the same way and with the same means (not shown) as in fig. 3.

CLAIMS

1. A method for establishing a health condition of an animal, such as a cow or a sheep, by analysing milk from the animal during or after a milking operation, **characterised by** capturing a sample of the milk from the last part of the milking operation and analysing the captured sample.

2. A method according to claim 1, **characterised in that** the analysing is provided on the milk from each udder quarter separately.

3. A method according to anyone of the preceding claims, **characterised in that** the analysing comprises measuring the light transmission, reflection or absorption of the milk sample.

4. A method according to claim 3, **characterised in that** the analysing comprises using selected wavelengths absorbed by specific molecules in compounds in the milk for the measuring of the light transmission, reflection or absorption of the milk sample.

5. A method according to anyone of the preceding claims, **characterised in that** the analysing comprises measuring the conductivity of the milk sample.

6. A method according to anyone of the preceding claims, **characterised in that** the capturing of the milk sample is provided in a catch pocket, for example a bent (4) a larger diameter line section (30), a threshold (32) or an extension (34) in a milk transport line (2).

7. A method according to claim 6, **characterised in that** the analysing is provided when the milking operation is ended and the milk sample to be analysed is left in the catch pocket (4, 30, 32, 34) in the milk transport line (2); and by providing an

airflow in the milk transport line (2) for stirring the milk sample during the analyse.

8. A method according to anyone of the preceding claims, **characterised in that** the capturing of the milk sample is provided in a separate sample container (10), when the milking operation is about to end.

9. A method according to claim 8, **characterised by** providing a normally closed valve (12) between a milk transport line (11) and the sample container (10); and opening the valve (12) when milk is to be captured.

10. A method according to claim 9, **characterised by** sensing the milk flow; and sending a signal for the valve (12) to open,

a) when the sensed milk flow has sunken below a predetermined rate or

b) when the sensed milk flow has sunken below a predetermined rate below the rate during the first and/or the middle part of the milking.

11. A method according to claim 9, **characterised by** opening the valve (12) after a predetermined time period.

12. A method according to claim 6 and 9-11, **characterised by** connecting the valve (12) to the catch pocket (4, 30, 32, 34) in the line (2), where the milk sample automatically stays.

13. A method according to anyone of the claims 8-12, **characterised in that** the analysing comprises measuring the relative amount of different constituents in the milk such as progesterone, urea and keton bodies by providing a biosensor (22) in the sample container (10).

14. A method according to anyone of the claims 8-13, **characterised by** draining and washing the sample container (10) through a second valve (18) in the sample container (10).

15. A method according to anyone of the preceding claims, **characterised by** storing the analysing results in a database (17) for each animal.

16. A system for establishing a health condition of an animal, such as a cow or a sheep, by analysing milk from the animal, during or after a milking operation, **characterised by** capturing means (4, 30, 32, 34, 10) for capturing a milk sample from the last part of the milking operation; and analysing means (6, 8; 6A,6B,6C, 8'; 6'', 8'', 16, 22) for analysing the captured milk sample.

17. A system according to claim 16, **characterised in that** said capturing means (4, 30, 32, 34, 10) are four, each connected to different udder quarters; and the analysing means (6, 8; 6A,6B,6C, 8'; 6'', 8'', 16, 22) is adapted to analyse separately the milk from each udder quarter.

18. A system according to anyone of the claims 16-17, **characterised in that** each capturing means (4, 30, 32, 34, 10) has a wall provided with a light source means (6; 6A, 6B,6C; 6'') outside one wall side and a light detector means (8) outside the opposite wall side, said wall sides being transparent for wavelengths of the actual light to be detected.

19. A system according to claim 18, **characterised in that** the light source means (6; 6A, 6B,6C; 6'') comprises a wavelength selector (7).

20. A system according to anyone of the claims 16-19, **characterised in that** the analysing means (6, 8; 6A,6B,6C, 8'; 6'', 8'', 16, 22) comprises means (16) for measuring the conductivity of the captured last milk from the milking operation

21. A system according to anyone of the claims 16-20, **characterised in that** each capturing means is a part of the milk transport line (2) and forms a catch pocket, for example a bend (4), a larger diameter line section (30), a threshold (32), an extension (34), of it.

22. A system according to claim 21, **characterised by** an airflow device (21) adapted to produce an airflow in the milk transport line (2) during the analysing operation.

23. A system according to claim 16-20, **characterised in that** each capturing means is a separate sample container (10) comprising a valve (12) connected to the milk transport line (11); and in that the system comprises control means (15) to open the valve (12) for milk when the milking operation is about to end.

24. A system according to claim 23, **characterised by** a flow sensor (13) in each milk transport line (11) for sensing the milk flow and cause a signal to the valve (12) to open, when

a) the sensed milk flow has sunken below a determined rate or

b) the sensed milk flow has sunken below a determined rate below the rate during the first and/or the middle part of the milking operation.

25. A system according to claim 23, **characterised in that** the control means (15) opens the valve (12) after a predetermined time period.

26. A system according to claim 21 and 23-25, **characterised in that** the valve (12) is connected to the catch pocket (4, 30, 32, 34) in the line (2), where the last milk automatically stays.

27. A system according to anyone of the claims 23-26, **characterised in that** the analysing means (6, 8; 6A,6B,6C, 8'; 6'', 8'', 16, 22) comprises a biosensor (22) for measuring the relative amount of different constituents in the milk such as progesterone, urea and keton bodies.

28. A system according to anyone of the claims 16-27, **characterised by** data bases (17) for storing the results from the analyses for each cow.

29. A system according to anyone of the claims 16-28, **characterised in that** the sample container (10) comprises a second valve (18) for draining and washing the sample container (10).

ABSTRACT

A system and a method for establishing a health condition of an animal, such as a cow or a sheep, by analysing milk from the animal during or after the milking operation.

According to the invention a sample of the milk from the last part of the milking operation is captured by capturing means (4) and analysing means (6A,6B,6C, 8') are used for making analyses of the captured milk sample.

(Fig. 2)

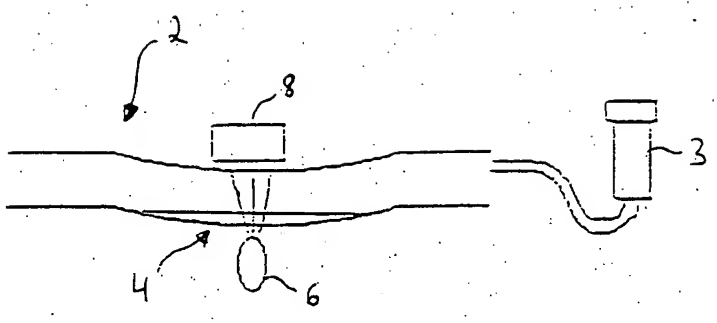

Fig. 1A

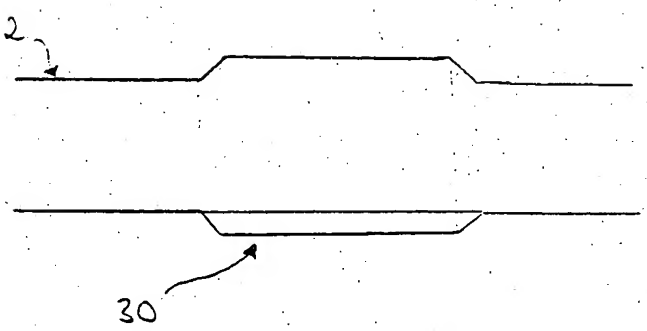

Fig. 1B

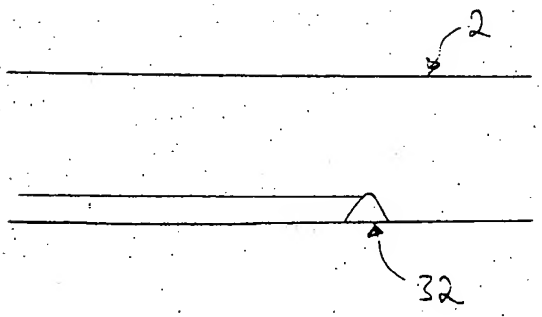

Fig. 1C

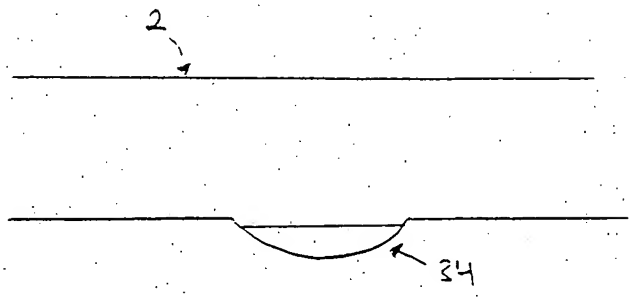

Fig. 1D

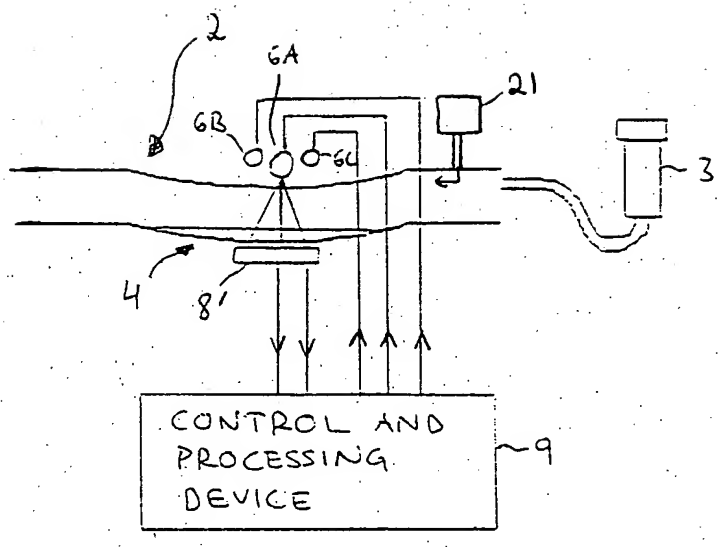

Fig. 2

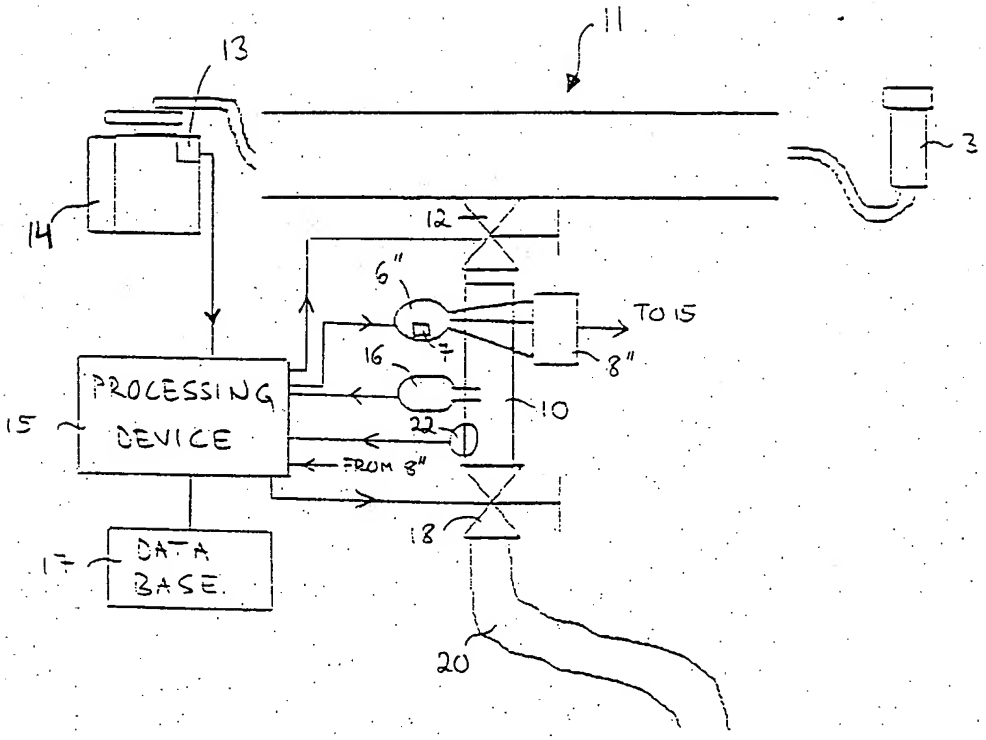
11
13
3
14
12
6"
TO 15
8"
16
10
PROCESSING DEVICE
15
22
FROM 8"
18
17
DATA BASE.
20

Fig. 3

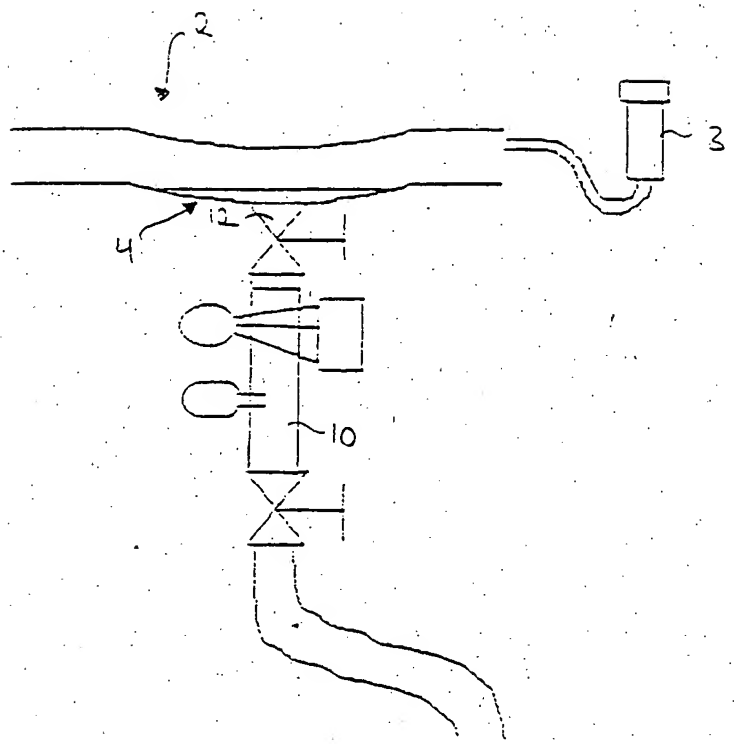

Fig. 4